

PATENT ABSTRACTS OF JAPAN

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(54) MOLTEN METAL HOLDING PIPE

(57)Abstract:

PROBLEM TO BE SOLVED: To improve the strength and the shielding property of the molten metal by laminating an inorganic fiber sheet in a winding manner through an inorganic shielding layer containing an inorganic powder and an inorganic adhesive, and specifying the total mass of the inorganic powder and the inorganic adhesive to hold the molten metal without cracking even when it is held for a long time.

SOLUTION: In a molten metal holding pipe, an inorganic fiber sheet is laminated in a winding manner through an inorganic shielding layer containing an inorganic powder and an inorganic adhesive, and the total mass of the inorganic powder and the inorganic adhesive is not less than two times the mass of the inorganic fiber sheet. Because the molten metal holding pipe uses the inorganic fiber sheet such as a silica-alumina fiber, the pipe is not cracked even when the molten metal is held for a long time, and it is excellent in strength. Also, the inorganic shielding layer containing a large volume of the inorganic powder such as feldspar and the inorganic adhesive such as silica sol is formed, and the shielding property of the molten metal is also excellent.

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CLAIMS

[Claim(s)]

[Claim 1] The molten-metal maintenance pipe which the winding laminating of the inorganic system fiber sheet is carried out through the inorganic shielding layer containing inorganic fine particles and inorganic adhesive, and is characterized by the sum total mass of inorganic fine particles and inorganic adhesive being twice [more than] the mass of an inorganic system fiber sheet.

[Claim 2] The molten-metal maintenance pipe according to claim 1 characterized by intermingling that whose thing and mean particle diameter of less than 10 micrometers mean particle diameter is 10-100 micrometers as inorganic fine particles.

[Claim 3] The molten-metal maintenance pipe according to claim 1 or 2 characterized by the content of the alkali-metal oxide in the whole inorganic material being less than [2mass%].

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a molten-metal maintenance pipe. It is related with the molten-metal maintenance pipe which can more specifically be used as the pipe for dead head formation at the time of cast manufacture, a pipe which constitutes the side-face part of the container for molten-metal extraction.

[0002]

[Description of the Prior Art] In case a casting was manufactured, in order to prevent a casting defect, the former to the dead head was required. However, since it is originally unnecessary, it is necessary to remove this dead head. Therefore, there was various futility, such as a point to which it is necessary to carry out melting of the metal of the point many which needs many metals by the dead head, and a point which needs to remove the dead head.

[0003] In order to lose such futility, a dielectric coil is fitted loosely into the outside of the fireproof pipe which embedde at mold and was set up so that it may be open for free passage to a mold mold cavity, and the method of carrying out induction heating of the molten metal in a fireproof pipe with an induction coil at the time of metal teeming, and making the molten metal in a fireproof pipe solidify is learned. Since according to this approach the dead head can be made smal and it ends with few metals, the time and effort which carries out melting, the time and effort which removes the dead head are mitigable.

[0004] By the way, the following thermal resistance is required for the fireproof pipe which occupies important specific gravity in this approach. That is, even if it twists 1,200 degrees C - 1,500 degrees C molten metal to hold for 20 - 40 minutes, a fireproof pipe needs to be able to hold inside molten metal also by heating molten metal with a dielectric coil, without being divided. Therefore, although a pottery pipe and extrusion-molding tubing were used as this fireproof pipe, thermal shock resistance is low (weak), and since it was easy to generate a crack, it was difficult [these fireproof pipes] to use it. On the other hand, ceramic fiber was used, and since the fireproof pipe which carried out suction shaping was not able to have low reinforcement or was not able to cover molten metal, it was difficult to use it.

[0005]

[Problem(s) to be Solved by the Invention] This invention is made in order to solve the above-mentioned trouble, it can t held, without being divided even if it carries out long duration maintenance of the molten metal, and aims at reinforcement offering the pipe which is excellent in the electric shielding nature of molten metal.

[0006]

[Means for Solving the Problem] The winding laminating of the molten-metal maintenance pipe of this invention is carried out through the inorganic shielding layer in which an inorganic system fiber sheet contains inorganic fine particle and inorganic adhesive, and the sum total mass of inorganic fine particles and inorganic adhesive is a twice [more than] as many thing as the mass of an inorganic system fiber sheet. Thus, since the molten-metal maintenance pipe of this invention is using the inorganic system fiber sheet, even if it carries out long duration maintenance of the molten metal, i does not break, and is excellent also in reinforcement. Moreover, since the inorganic shielding layer which contains inorganic fine particles and inorganic adhesive in large quantities is formed, it excels also in the electric shielding nature of molten metal.

[0007] In order that mean particle diameter may tend to arrange the molten-metal maintenance pipe with which the less than 10-micrometer thing and the thing whose mean particle diameter is 10-100 micrometers were intermingled in the condition with these precise inorganic fine particles as the above-mentioned inorganic fine particles, reinforcement can b raised more and the electric shielding nature of molten metal is also more excellent.

[0008] Moreover, since the molten-metal maintenance pipe not more than 2mass% cannot produce melting point lowerin of a mineral constituent easily, the content of the alkali-metal oxide in the whole inorganic material is excellent in therma resistance, and it cannot produce a crack more easily.

[0009]

[Embodiment of the Invention] The inorganic system fiber sheet of this invention makes the inorganic fiber the subject sc

that it may excel in thermal resistance, and thermal shock resistance is given to a molten-metal maintenance pipe by existence of this inorganic system fiber sheet. It is desirable that it is a nonwoven fabric so that it may excel in holdout, such as inorganic fine particles, as a mode of this fiber sheet, for example, although it can be textiles, knitting, and a nonwoven fabric. Although this suitable nonwoven fabric can be manufactured with the wet milling-paper method and dry process of a conventional method, it is more desirable to manufacture by the wet milling-paper method for excelling in homogeneity.

[0010] As an inorganic fiber which constitutes this inorganic system fiber sheet, silica-alumina fiber, an alumina fiber, a silica fiber, a glass fiber, a carbon fiber, silicon carbide fiber, rock wool, one or more kinds of metal fibers, etc. can be used, for example. The silica-alumina fiber which is excellent in the maintenance nature of hot fiber reinforcement also in these, an alumina fiber, a silica fiber, or silicon carbide fiber can be used suitably.

[0011] In addition, although the inorganic system fiber sheet in this invention should just contain the inorganic fiber beyond 50mass%, it contains the inorganic fiber beyond 70mass% preferably, and contains the inorganic fiber beyond 90mass% more preferably. In addition, depending on heat-resistant fiber, such as aromatic polyamide fiber of a metasytem or the Para system, polyamidoimide fiber, polytetrafluoroethylene fiber, aromatic series polyether amide fiber, and Pori Daimler Benz imidazole fiber, and the case, a regenerated fiber, a semi-synthetic fiber, a synthetic fiber, a vegetable fiber, and an animal fiber can also be included within limits which do not have a bad influence on thermal resistance etc. as fiber other than the inorganic fiber which constitutes an inorganic system fiber sheet.

[0012] As for the diameter of fiber of the fiber which constitutes this inorganic system fiber sheet, it is desirable that it is 0.5-20 micrometers, and it is more desirable that it is 1-10 micrometers so that it may excel in homogeneity. Moreover, as for fiber length, it is desirable that it is 1mm or more so that it may excel in thermal shock resistance. In addition, when manufacturing a nonwoven fabric by the suitable wet milling-paper method, it is desirable that it is below manufacture to 20mm length.

[0013] As for the apparent density of this inorganic system fiber sheet, it is desirable that it is 0.05 - 0.5 g/cm³, and it is more desirable that it is 0.1 - 0.3 g/cm³ so that it may excel in thermal shock resistance and gestalt stability.

[0014] The molten-metal maintenance pipe of this invention is pasted up through the inorganic shielding layer in which the above inorganic system fiber sheets contain inorganic fine particles and inorganic adhesive. As this inorganic adhesive, one or more kinds of cement, such as a silica sol, alumina sol, a zirconia sol, a silicate, phosphate or alumina cement, magnesia cement, and zirconia cement, can be used, for example.

[0015] As inorganic fine particles, for example Moreover, a feldspar, a magnesia, the diatom earth, A silica, a silica alumina, a mullite, an alumina, an aluminum hydroxide, Zircon, a zirconia, titanium oxide, a magnesium oxide, a calcium oxide, A calcium silicate, a magnesium silicate, milt, milt balun, A pearlite, glass, glass balun, a dolomite, a chamotte, a mica, Cordierite, silicon nitride, boron nitride, silicon carbide, boron carbide, Clay minerals, such as metal system fine particles, carbon system fine particles or a kaolin, a bentonite, agalmatolite, talc, bayerite, a diaspore, sepiolite, attapulgite, a montmorillonite, hectorite, a synthetic fluorine mica, and a smectite, can be used.

[0016] If the clay mineral is included also in these inorganic fine particles, it excels in thermal resistance and non-****, and moreover the viscosity of the mixed liquor of inorganic fine particles and inorganic adhesive can be adjusted, and since it is effective in making homogeneity distribute inorganic fine particles, it can be used suitably. As for this clay mineral, it is desirable to occupy 1 - 30mass% of the inorganic whole fine particles. When there is an inclination for adjustment of viscosity to become difficult less than [1mass%], and it to become difficult to make homogeneity distribute inorganic fine particles, 30mass% is exceeded, the inorganic shielding layer which the solution retention of mixed liquor becomes high and becomes from a lot of inorganic fine particles and inorganic adhesives cannot be formed or fine particles cannot invade into an inorganic system fiber sheet, it is because there is an inclination for reinforcement to fall, and it is 3 - 20mass% more preferably. In addition, as some above-mentioned clay minerals, sodium silicate, an ultrafine particle with a particle size of 1 micrometer or less, or an organic macromolecule may be used, and viscosity may be adjusted instead.

[0017] Although mean particle diameter can use what is 0.1-100 micrometers as these inorganic fine particles, if a thing with a mean particle diameter of less than 10 micrometers and a thing with a mean particle diameter of 10 micrometers - 100 micrometers are used together, since it is easy to arrange inorganic fine particles in the precise condition, and the reinforcement of a molten-metal maintenance pipe can be raised more or it excels also in the electric shielding nature of molten metal, it is suitable. Moreover, since the uniform inorganic shielding layer which contains a lot of inorganic fine particles and inorganic adhesives by using together can be formed, the effectiveness of excelling by the electric shielding nature of molten metal also does so. Furthermore, in the thickness direction of an inorganic system fiber sheet, since a difference can be prepared in the distribution condition of inorganic fine particles and inorganic adhesive, the effectiveness of being harder coming to generate a crack also does so.

[0018] When using these inorganic fine particles together, as for the rate of a mass ratio of inorganic fine particles with a mean particle diameter of less than 10 micrometers and inorganic fine particles with a mean particle diameter of 10 micrometers - 100 micrometers, it is desirable that it is 1:9-9:1, and it is more desirable that it is 3:7-7:3 so that the

inorganic shielding layer containing a lot of inorganic fine particles can be formed, and so that it may excel in workability and a uniform inorganic shielding layer can be formed. In addition, inorganic fine particles with a mean particle diameter of less than 10 micrometers and inorganic fine particles with a mean particle diameter of 10 micrometers - 100 micrometers may be classes which are different even if it is the same class. Moreover, inorganic fine particles with a mean particle diameter of less than 10 micrometers and/or inorganic fine particles with a mean particle diameter of 10 micrometers - 100 micrometers should just consist of one or more kinds.

[0019] Moreover, as for the ratio (solid content) of inorganic fine particles and inorganic adhesive, it is desirable that it is 99:1-50:50, and it is more desirable that it is 95:5-70:30 so that it may excel in adhesive strength, and so that the inorganic shielding layer containing a lot of inorganic fine particles and inorganic adhesive can be formed.

[0020] Since the winding laminating of the inorganic system fiber sheet is carried out through the above inorganic shielding layers and the sum total mass of these inorganic fine particles and inorganic adhesive exists in large quantities more than (preferably 2.5 or more times, more preferably 3 or more times) with the twice of the mass of an inorganic system fiber sheet, the molten-metal maintenance pipe of this invention is excellent in the electric shielding nature of molten metal.

[0021] Moreover, since it is hard to produce melting point lowering of a mineral constituent that the content of the alkali-metal oxide in the whole inorganic material is less than [2mass%] (preferably 1.5mass(es)% less than, more preferably 1mass% less than, most preferably 0.5mass(es)% less than), and it is harder to produce a crack when molten metal is held, it is suitable. In addition, although an alkaline-earth-metal oxide has the operation smaller than an alkali-metal oxide which causes melting point lowering of a mineral constituent, since it has the operation which causes melting point lowering, it is desirable that the sum total content in the whole inorganic material of an alkali-metal oxide and an alkaline-earth-metal oxide is less than [3mass%], it is more desirable that it is less than [2.5mass%], and it is most desirable [an oxide] that it is less than [2mass%]. This inorganic material means ingredients which consist of a mineral constituent which constitutes a molten-metal maintenance pipe, such as an inorganic fiber, inorganic fine particles, and inorganic adhesive. Therefore, as an inorganic fiber, silica-alumina fiber, an alumina fiber, a silica fiber, silicon carbide fiber, etc. can be used suitably. Moreover, as inorganic fine particles, the diatom earth, a silica, a silica alumina, a mullite, an alumina, an aluminum hydroxide, zircon, a chamotte, a pearlite, a zirconia, titanium oxide, silicon nitride, boron nitride, silicon carbide, boron carbide, metal system fine particles, carbon system fine particles, etc. can be used suitably. Furthermore, as inorganic adhesive, a silica sol, alumina sol, a zirconia sol, etc. can be used suitably.

[0022] Such a molten-metal maintenance pipe of this invention can be manufactured as follows, for example. First, an inorganic system fiber sheet, the mixed solution of inorganic fine particles and inorganic adhesive, and the core material (henceforth "a contractile core material") contracted by desiccation are prepared.

[0023] Subsequently, it winds around a contractile core material, after giving the mixed solution of inorganic fine particles and inorganic adhesive to an inorganic system fiber sheet. For example, there are an approach of applying to one side of an inorganic system fiber sheet, using spreading machines, such as a roll coater, a knife coating machine, and a curtain coating machine, as an approach of giving the mixed solution of inorganic fine particles and inorganic adhesive to this inorganic system fiber sheet, the approach of sinking into the inorganic whole system fiber sheet by a sinking-in coating machine etc., etc. Also in these, if it applies only to one side with a spreading machine, since it is easy to control the amount of grants uniformly and excels also in work environment moreover, it is suitable.

[0024] Moreover, as for the mixed solution of inorganic fine particles and inorganic adhesive, it is desirable that a lot of mixed solutions can be given in order to form an inorganic shielding layer. Therefore, as for the viscosity of a mixed solution, it is desirable that it is about 100-10,000cps.

[0025] As the winding approach to the contractile core material of the inorganic system fiber sheet which gave the mixed solution of this inorganic fine particles and inorganic adhesive, there are a planospiral and the approach of winding spirally, for example. Moreover, although this inorganic system fiber sheet may be wound so that it may become how many layers on a contractile core material, it is desirable that it is uniform and reinforcement to wind so that it may become three or more layers so that it may excel in melting metal shield nature.

[0026] Subsequently, where the inorganic system fiber sheet which gave the above-mentioned mixed solution is wound around a contractile core material, after drying, the molten-metal maintenance pipe of this invention can be manufactured by drawing out a contractile core material. That is, since the contractile core material swollen when the inorganic system fiber sheet which gave the mixed solution was wound around a contractile core material contracts when it dries, it can sample easily, without damaging a molten-metal maintenance pipe.

[0027] Although it changes as this contractile core material with solvents which constitute a mixed solution, it is desirable to, use the contractile core material which consists of an ingredient of a cellulose system like paper or wood for example, when a solvent is a drainage system. When this solvent is a drainage system, more specifically, what cast a paper tube, log material, the square bar, or a water soluble polymer can be used.

[0028] Moreover, as the desiccation approach, it may heat or you may be an air dried. In addition, when air-dry, dehumidifying is more desirable so that it may be easy to sample a contractile core material.

[0029] Although the example of this invention is indicated below, this invention is not limited to the following examples.
[0030]

[Example] (Examples 1-5, example of a comparison) By the wet milling-paper method, the inorganic system nonwoven fabric of 3 was manufactured surface density 100 g/m² which combined silica-alumina fiber (the diameter of fiber of 2-3 micrometers, fiber length of 1-10mm) by 3mass(es)% vinylon, the thickness of 0.5mm, and the apparent density of 0.2g/cm.

[0031] Subsequently, only the amount which shows the water solution containing inorganic fine particles as shown in Table 1, and inorganic adhesive in Table 1 by the roll coater at one side of the above-mentioned inorganic system nonwoven fabric was applied. Subsequently, the planospiral of the inorganic system nonwoven fabric which applied the water solution containing inorganic fine particles and inorganic adhesive on the paper tube (the bore of 50mm, outer diameter of 60mm) which deck-watertight-luminaire-ization-processed the front face was carried out 5 times. Then, after drying for 10 hours, ventilating at 40 degrees C, said paper tube was sampled and cut out and the molten-metal maintenance pipe with a die length [of 500mm] and an outer diameter of 66mm was manufactured.

[0032]

[Table 1]

		実施例1	実施例2	実施例3	実施例4	実施例5	比較例
無機系不織布の面密度 (g/m ²)	無機系不織布の面密度 (g/m ²)	100	100	100	100	100	100
	コロイダルシリカ 粒径 0.01~0.02 μm (mass %)	20	20	20	20	20	20
	セピオライト ^{#1} 粒径 0.02~10 μm (mass %)	10	10	10	10	10	10
	ムライト 粒径 1~10 μm (mass %)	40	20	70	--	40	40
	ムライト 粒径 10~100 μm (mass %)	30	20	--	70	30	30
	長石 ^{#2} 粒径 1~10 μm (mass %)	--	30	--	--	--	--
	粘度 (cps)	5,000	5,000	5,000	5,000	5,000	5,000
	塗布量 (固形分) ^{#3} (g/m ²)	500 (5)	500 (5)	500 (5)	500 (5)	250 (2.5)	150 (1.5)
巻回作業性	巻回作業性	良好	良好	やや染み 出しやす い	ややはが れ易い	良好	はがれ易 い
	含有率 ^{#4} (mass %)	0 (1.9)	2.3 (4.2)	0 (1.9)	0 (1.9)	0 (1.7)	0 (1.4)
耐熱性 ^{#5}	耐熱性 ^{#5}	○	△	○	○	△	×

#1 ; MgO を 23mass % 含有

#2 ; Na₂O, K₂O を 9mass % 含有

#3 ; 括弧内は無機系不織布の質量に対する無機粉体と無機接着剤の合計質量の倍率 (倍)

#4 ; 無機材料全体におけるアルカリ金属酸化物の含有率、括弧内は無機材料全体におけるアルカリ金属酸化物及びアルカリ土類金属酸化物の合計含有率

#5 ; ○・・溶融金属保持パイプのふくれも割れもなし

△・・溶融金属保持パイプがややふくれるものの、割れはなし

×・・溶融金属保持パイプがふくれ、割れが発生

[0033] (Example 6) The molten-metal maintenance pipe with a die length [of 500mm] and an outer diameter of 66mm was manufactured completely like the example 1 except having applied the water solution containing inorganic fine particles as shown in Table 2, and inorganic adhesive to the same inorganic system nonwoven fabric as an example 1 by the roll coater (500g/m²).

[0034]

[Table 2]

		実施例 6
無機系不織布の面密度 (g/m ²)	無機系不織布の面密度 (g/m ²)	100
	コロイダルシリカ 粒径 0.01~0.02 μm (mass%)	18
	珪目粘土 粒径 0.02~10 μm (mass%)	18
	ムライト 粒径 1~10 μm (mass%)	36
	ムライト 粒径 10~100 μm (mass%)	28
	粘度 (cps)	5,000
	塗布量(固形分) ^{#1} (g/m ²)	500 (5)
成成分	巻回作業性	良好
	含有率 ^{#2} (mass%)	0 (0)
	耐熱性 ^{#3}	○

#1 ; 括弧内は無機系不織布の質量に対する無機粉体と無機接着剤の合計質量の倍率(倍)

#2 ; 無機材料全体におけるアルカリ金属酸化物の含有率、括弧内は無機材料全体におけるアルカリ金属酸化物及びアルカリ土類金属酸化物の合計含有率

#3 ; ○・・溶融金属保持パイプのふくれも割れもなし

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[0035] (Winding workability) The result of the winding workability at the time of manufacturing each molten-metal maintenance pipe of examples 1-6 and the example of a comparison is shown in Table 1 and 2. When the inorganic fine particles whose inorganic fine particles and mean particle diameter of less than 10 micrometers mean particle diameter is 10-100 micrometers are intermingled from these results, it turns out that it excels in winding workability.

[0036] (Heat resistance test) The part from the lower limit of the molten-metal maintenance pipe of examples 1-6 and the example of a comparison to about 60mm was laid under the furan mold, respectively (it is a right angle to furan mold), and the lower limit of a molten-metal maintenance pipe was blocked. Subsequently, molten metal with a temperature of about 1,300 degrees C was poured in inside each molten-metal maintenance pipe from the lower limit of a molten-metal maintenance pipe to height of about 400mm. Subsequently, inside molten metal was heated with high-frequency-dielectric-heating equipment from the perimeter of a molten-metal maintenance pipe, and the temperature of molten metal was maintained for 30 minutes at about 1,300 degrees C. Then, the condition of each molten-metal maintenance pipe was observed. This result is also shown in Table 1 and 2.

[0037] From these results, if the content of the alkali-metal oxide in the whole (1) inorganic material is less than [2mass%] If the sum total mass of excelling with thermal resistance, (2) inorganic fine particles, and inorganic adhesive is twice [more than (especially 3 or more times)] the inorganic system nonwoven fabric Excelling in thermal resistance more, when excelling in thermal resistance more and the inorganic fine particles whose inorganic fine particles and mean particle diameter of less than 10 micrometers (3) mean particle diameter is 10-100 micrometers are intermingled, ****, c**.

[0038]

[Effect of the Invention] The winding laminating of the molten-metal maintenance pipe of this invention is carried out through the inorganic shielding layer in which an inorganic system fiber sheet contains inorganic fine particles and inorganic adhesive, and the sum total mass of inorganic fine particles and inorganic adhesive is a twice [more than] as many thing as the mass of an inorganic system fiber sheet. Thus, since the molten-metal maintenance pipe of this invention is using the inorganic system fiber sheet, even if it carries out long duration maintenance of the molten metal, it does not break, and is excellent also in reinforcement. Moreover, since the inorganic shielding layer which contains inorganic fine particles and inorganic adhesive in large quantities is formed, it excels also in the electric shielding nature of molten metal.

[0039] In order that mean particle diameter may tend to arrange the molten-metal maintenance pipe with which the less than 10-micrometer thing and the thing whose mean particle diameter is 10-100 micrometers were intermingled in the condition with these precise inorganic fine particles as the above-mentioned inorganic fine particles, reinforcement can be raised more and the electric shielding nature of molten metal is also more excellent.

[0040] Moreover, since the molten-metal maintenance pipe not more than 2mass% cannot produce melting point lowering of a mineral constituent easily, the content of the alkali-metal oxide in the whole inorganic material is excellent in thermal resistance, and it cannot produce a crack more easily.

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TECHNICAL FIELD

[Field of the Invention] This invention relates to a molten-metal maintenance pipe. It is related with the molten-metal maintenance pipe which can more specifically be used as the pipe for dead head formation at the time of cast manufacture, a pipe which constitutes the side-face part of the container for molten-metal extraction.

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PRIOR ART

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[0003] In order to lose such futility, a dielectric coil is fitted loosely into the outside of the fireproof pipe which embedde at mold and was set up so that it may be open for free passage to a mold mold cavity, and the method of carrying out induction heating of the molten metal in a fireproof pipe with an induction coil at the time of metal teeming, and making the molten metal in a fireproof pipe solidify is learned. Since according to this approach the dead head can be made small and it ends with few metals, the time and effort which carries out melting, the time and effort which removes the dead head are mitigable.

[0004] By the way, the following thermal resistance is required for the fireproof pipe which occupies important specific gravity in this approach. That is, even if it twists 1,200 degrees C - 1,500 degrees C molten metal to hold for 20 - 40 minutes, a fireproof pipe needs to be able to hold inside molten metal also by heating molten metal with a dielectric coil, without being divided. Therefore, although a pottery pipe and extrusion-molding tubing were used as this fireproof pipe, thermal shock resistance is low (weak), and since it was easy to generate a crack, it was difficult [these fireproof pipes] to use it. On the other hand, ceramic fiber was used, and since the fireproof pipe which carried out suction shaping was not able to have low reinforcement or was not able to cover molten metal, it was difficult to use it.

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EFFECT OF THE INVENTION

[Effect of the Invention] The winding laminating of the molten-metal maintenance pipe of this invention is carried out through the inorganic shielding layer in which an inorganic system fiber sheet contains inorganic fine particles and inorganic adhesive, and the sum total mass of inorganic fine particles and inorganic adhesive is a twice [more than] as many thing as the mass of an inorganic system fiber sheet. Thus, since the molten-metal maintenance pipe of this invention is using the inorganic system fiber sheet, even if it carries out long duration maintenance of the molten metal, it does not break, and is excellent also in reinforcement. Moreover, since the inorganic shielding layer which contains inorganic fine particles and inorganic adhesive in large quantities is formed, it excels also in the electric shielding nature of molten metal.

[0039] In order that mean particle diameter may tend to arrange the molten-metal maintenance pipe with which the less than 10-micrometer thing and the thing whose mean particle diameter is 10-100 micrometers were intermingled in the condition with these precise inorganic fine particles as the above-mentioned inorganic fine particles, reinforcement can be raised more and the electric shielding nature of molten metal is also more excellent.

[0040] Moreover, since the molten-metal maintenance pipe not more than 2mass% cannot produce melting point lower than of a mineral constituent easily, the content of the alkali-metal oxide in the whole inorganic material is excellent in thermal resistance, and it cannot produce a crack more easily.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] This invention is made in order to solve the above-mentioned trouble, it can be held, without being divided even if it carries out long duration maintenance of the molten metal, and aims at reinforcement offering the pipe which is excellent in the electric shielding nature of molten metal.

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MEANS

[Means for Solving the Problem] The winding laminating of the molten-metal maintenance pipe of this invention is carried out through the inorganic shielding layer in which an inorganic system fiber sheet contains inorganic fine particles and inorganic adhesive, and the sum total mass of inorganic fine particles and inorganic adhesive is a twice [more than] as many thing as the mass of an inorganic system fiber sheet. Thus, since the molten-metal maintenance pipe of this invention is using the inorganic system fiber sheet, even if it carries out long duration maintenance of the molten metal, does not break, and is excellent also in reinforcement. Moreover, since the inorganic shielding layer which contains inorganic fine particles and inorganic adhesive in large quantities is formed, it excels also in the electric shielding nature of molten metal.

[0007] In order that mean particle diameter may tend to arrange the molten-metal maintenance pipe with which the less than 10-micrometer thing and the thing whose mean particle diameter is 10-100 micrometers were intermingled in the condition with these precise inorganic fine particles as the above-mentioned inorganic fine particles, reinforcement can be raised more and the electric shielding nature of molten metal is also more excellent.

[0008] Moreover, since the molten-metal maintenance pipe not more than 2mass% cannot produce melting point lowering of a mineral constituent easily, the content of the alkali-metal oxide in the whole inorganic material is excellent in thermal resistance, and it cannot produce a crack more easily.

[0009]

[Embodiment of the Invention] The inorganic system fiber sheet of this invention makes the inorganic fiber the subject so that it may excel in thermal resistance, and thermal shock resistance is given to a molten-metal maintenance pipe by existence of this inorganic system fiber sheet. It is desirable that it is a nonwoven fabric so that it may excel in holdout, such as inorganic fine particles, as a mode of this fiber sheet, for example, although it can be textiles, knitting, and a nonwoven fabric. Although this suitable nonwoven fabric can be manufactured with the wet milling-paper method and dry process of a conventional method, it is more desirable to manufacture by the wet milling-paper method for excelling in homogeneity.

[0010] As an inorganic fiber which constitutes this inorganic system fiber sheet, silica-alumina fiber, an alumina fiber, a silica fiber, a glass fiber, a carbon fiber, silicon carbide fiber, rock wool, one or more kinds of metal fibers, etc. can be used, for example. The silica-alumina fiber which is excellent in the maintenance nature of hot fiber reinforcement also these, an alumina fiber, a silica fiber, or silicon carbide fiber can be used suitably.

[0011] In addition, although the inorganic system fiber sheet in this invention should just contain the inorganic fiber beyond 50mass%, it contains the inorganic fiber beyond 70mass% preferably, and contains the inorganic fiber beyond 90mass% more preferably. In addition, depending on heat-resistant fiber, such as aromatic polyamide fiber of a metasystem or the Para system, polyamidoimide fiber, polytetrafluoroethylene fiber, aromatic series polyether amide fiber, and Pori Daimler Benz imidazole fiber, and the case, a regenerated fiber, a semi-synthetic fiber, a synthetic fiber, a vegetable fiber, and an animal fiber can also be included within limits which do not have a bad influence on thermal resistance etc. as fiber other than the inorganic fiber which constitutes an inorganic system fiber sheet.

[0012] As for the diameter of fiber of the fiber which constitutes this inorganic system fiber sheet, it is desirable that it is 0.5-20 micrometers, and it is more desirable that it is 1-10 micrometers so that it may excel in homogeneity. Moreover, as for fiber length, it is desirable that it is 1mm or more so that it may excel in thermal shock resistance. In addition, when manufacturing a nonwoven fabric by the suitable wet milling-paper method, it is desirable that it is below manufacture to 20mm length.

[0013] As for the apparent density of this inorganic system fiber sheet, it is desirable that it is 0.05 - 0.5 g/cm³, and it is more desirable that it is 0.1 - 0.3 g/cm³ so that it may excel in thermal shock resistance and gestalt stability.

[0014] The molten-metal maintenance pipe of this invention is pasted up through the inorganic shielding layer in which the above inorganic system fiber sheets contain inorganic fine particles and inorganic adhesive. As this inorganic adhesive, one or more kinds of cement, such as a silica sol, alumina sol, a zirconia sol, a silicate, phosphate or alumina cement, magnesia cement, and zirconia cement, can be used, for example.

[0015] As inorganic fine particles, for example Moreover, a feldspar, a magnesite, the diatom earth, A silica, a silica alumina, a mullite, an alumina, an aluminum hydroxide, Zircon, a zirconia, titanium oxide, a magnesium oxide, a calcium oxide, A calcium silicate, a magnesium silicate, milt, milt balun, A pearlite, glass, glass balun, a dolomite, a chamotte, a mica, Cordierite, silicon nitride, boron nitride, silicon carbide, boron carbide, Clay minerals, such as metal system fine particles, carbon system fine particles or a kaolin, a bentonite, agalmatolite, talc, bayerite, a diaspore, sepiolite, attapulgite, a montmorillonite, hectorite, a synthetic fluorine mica, and a smectite, can be used.

[0016] If the clay mineral is included also in these inorganic fine particles, it excels in thermal resistance and non-****, and moreover the viscosity of the mixed liquor of inorganic fine particles and inorganic adhesive can be adjusted, and since it is effective in making homogeneity distribute inorganic fine particles, it can be used suitably. As for this clay mineral, it is desirable to occupy 1 - 30mass% of the inorganic whole fine particles. When there is an inclination for adjustment of viscosity to become difficult less than [1mass%], and it to become difficult to make homogeneity distribute inorganic fine particles, 30mass% is exceeded, the inorganic shielding layer which the solution retention of mixed liquor becomes high and becomes from a lot of inorganic fine particles and inorganic adhesives cannot be formed or fine particles cannot invade into an inorganic system fiber sheet, it is because there is an inclination for reinforcement to fall, and it is 3 - 20mass% more preferably. In addition, as some above-mentioned clay minerals, sodium silicate, an ultrafine particle with a particle size of 1 micrometer or less, or an organic macromolecule may be used, and viscosity may be adjusted instead.

[0017] Although mean particle diameter can use what is 0.1-100 micrometers as these inorganic fine particles, if a thing with a mean particle diameter of less than 10 micrometers and a thing with a mean particle diameter of 10 micrometers - 100 micrometers are used together, since it is easy to arrange inorganic fine particles in the precise condition, and the reinforcement of a molten-metal maintenance pipe can be raised more or it excels also in the electric shielding nature of molten metal, it is suitable. Moreover, since the uniform inorganic shielding layer which contains a lot of inorganic fine particles and inorganic adhesives by using together can be formed, the effectiveness of excelling by the electric shielding nature of molten metal also does so. Furthermore, in the thickness direction of an inorganic system fiber sheet, since a difference can be prepared in the distribution condition of inorganic fine particles and inorganic adhesive, the effectiveness of being harder coming to generate a crack also does so.

[0018] When using these inorganic fine particles together, as for the rate of a mass ratio of inorganic fine particles with mean particle diameter of less than 10 micrometers and inorganic fine particles with a mean particle diameter of 10 micrometers - 100 micrometers, it is desirable that it is 1:9-9:1, and it is more desirable that it is 3:7-7:3 so that the inorganic shielding layer containing a lot of inorganic fine particles can be formed, and so that it may excel in workability and a uniform inorganic shielding layer can be formed. In addition, inorganic fine particles with a mean particle diameter of less than 10 micrometers and inorganic fine particles with a mean particle diameter of 10 micrometers - 100 micrometers may be classes which are different even if it is the same class. Moreover, inorganic fine particles with a mean particle diameter of less than 10 micrometers and/or inorganic fine particles with a mean particle diameter of 10 micrometers - 100 micrometers should just consist of one or more kinds.

[0019] Moreover, as for the ratio (solid content) of inorganic fine particles and inorganic adhesive, it is desirable that it is 99:1-50:50, and it is more desirable that it is 95:5-70:30 so that it may excel in adhesive strength, and so that the inorganic shielding layer containing a lot of inorganic fine particles and inorganic adhesive can be formed.

[0020] Since the winding laminating of the inorganic system fiber sheet is carried out through the above inorganic shielding layers and the sum total mass of these inorganic fine particles and inorganic adhesive exists in large quantities more than (preferably 2.5 or more times, more preferably 3 or more times) with the twice of the mass of an inorganic system fiber sheet, the molten-metal maintenance pipe of this invention is excellent in the electric shielding nature of molten metal.

[0021] Moreover, since it is it hard to produce melting point lowering of a mineral constituent that the content of the alkali-metal oxide in the whole inorganic material is less than [2mass%] (preferably 1.5mass(es)% less than, more preferably 1mass% less than, most preferably 0.5mass(es)% less than), and it is harder to produce a crack when molten metal is held, it is suitable. In addition, although an alkaline-earth-metal oxide has the operation smaller than an alkali-metal oxide which causes melting point lowering of a mineral constituent, since it has the operation which causes melting point lowering, it is desirable that the sum total content in the whole inorganic material of an alkali-metal oxide and an alkaline-earth-metal oxide is less than [3mass%], it is more desirable that it is less than [2.5mass%], and it is most desirable [an oxide] that it is less than [2mass%]. This inorganic material means ingredients which consist of a mineral constituent which constitutes a molten-metal maintenance pipe, such as an inorganic fiber, inorganic fine particles, and inorganic adhesive. Therefore, as an inorganic fiber, silica-alumina fiber, an alumina fiber, a silica fiber, silicon carbide fiber, etc. can be used suitably. Moreover, as inorganic fine particles, the diatom earth, a silica, a silica alumina, a mullite, an alumina, an aluminum hydroxide, zircon, a chamotte, a pearlite, a zirconia, titanium oxide, silicon nitride, boron nitride, silicon carbide, boron carbide, metal system fine particles, carbon system fine particles, etc. can be used suitably. Furthermore, as inorganic adhesive, a silica sol, alumina sol, a zirconia sol, etc. can be used suitably.

[0022] Such a molten-metal maintenance pipe of this invention can be manufactured as follows, for example. First, an inorganic system fiber sheet, the mixed solution of inorganic fine particles and inorganic adhesive, and the core material (henceforth "a contractile core material") contracted by desiccation are prepared.

[0023] Subsequently, it winds around a contractile core material, after giving the mixed solution of inorganic fine particles and inorganic adhesive to an inorganic system fiber sheet. For example, there are an approach of applying to one side of an inorganic system fiber sheet, using spreading machines, such as a roll coater, a knife coating machine, and a curtain coating machine, as an approach of giving the mixed solution of inorganic fine particles and inorganic adhesive to this inorganic system fiber sheet, the approach of sinking into the inorganic whole system fiber sheet by a sinking-in coating machine etc., etc. Also in these, if it applies only to one side with a spreading machine, since it is easy to control the amount of grants uniformly and excels also in work environment moreover, it is suitable.

[0024] Moreover, as for the mixed solution of inorganic fine particles and inorganic adhesive, it is desirable that a lot of mixed solutions can be given in order to form an inorganic shielding layer. Therefore, as for the viscosity of a mixed solution, it is desirable that it is about 100-10,000cps.

[0025] As the winding approach to the contractile core material of the inorganic system fiber sheet which gave the mixed solution of this inorganic fine particles and inorganic adhesive, there are a planospiral and the approach of winding spirally, for example. Moreover, although this inorganic system fiber sheet may be wound so that it may become how many layers on a contractile core material, it is desirable that it is uniform and reinforcement to wind so that it may become three or more layers so that it may excel in melting metal shield nature.

[0026] Subsequently, where the inorganic system fiber sheet which gave the above-mentioned mixed solution is wound around a contractile core material, after drying, the molten-metal maintenance pipe of this invention can be manufactured by drawing out a contractile core material. That is, since the contractile core material swollen when the inorganic system fiber sheet which gave the mixed solution was wound around a contractile core material contracts when it dries, it can sample easily, without damaging a molten-metal maintenance pipe.

[0027] Although it changes as this contractile core material with solvents which constitute a mixed solution, it is desirable to, use the contractile core material which consists of an ingredient of a cellulose system like paper or wood for example when a solvent is a drainage system. When this solvent is a drainage system, more specifically, what cast a paper tube, a material, the square bar, or a water soluble polymer can be used.

[0028] Moreover, as the desiccation approach, it may heat or you may be an air dried. In addition, when air-dry, dehumidifying is more desirable so that it may be easy to sample a contractile core material.

[0029] Although the example of this invention is indicated below, this invention is not limited to the following example:

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EXAMPLE

[Example] (Examples 1-5, example of a comparison) By the wet milling-paper method, the inorganic system nonwoven fabric of 3 was manufactured surface density 100 g/m² which combined silica-alumina fiber (the diameter of fiber of 2-3 micrometers, fiber length of 1-10mm) by 3mass(es)% vinylon, the thickness of 0.5mm, and the apparent density of 0.2g/cm.

[0031] Subsequently, only the amount which shows the water solution containing inorganic fine particles as shown in Table 1, and inorganic adhesive in Table 1 by the roll coater at one side of the above-mentioned inorganic system nonwoven fabric was applied. Subsequently, the planospiral of the inorganic system nonwoven fabric which applied the water solution containing inorganic fine particles and inorganic adhesive on the paper tube (the bore of 50mm, outer diameter of 60mm) which deck-watertight-luminaire-ization-processed the front face was carried out 5 times. Then, after drying for 10 hours, ventilating at 40 degrees C, said paper tube was sampled and cut out and the molten-metal maintenance pipe with a die length [of 500mm] and an outer diameter of 66mm was manufactured.

[0032]

[Table 1]

		実施例 1	実施例 2	実施例 3	実施例 4	実施例 5	比較例
無機系不織布の面密度 (g/m ²)	無機系不織布の面密度 (g/m ²)	100	100	100	100	100	100
	コロイダルシリカ 粒径 0.01~0.02 μm (mass %)	20	20	20	20	20	20
	セピオライト ^{#1} 粒径 0.02~10 μm (mass %)	10	10	10	10	10	10
	ムライト 粒径 1~10 μm (mass %)	40	20	70	--	40	40
	ムライト 粒径 10~100 μm (mass %)	30	20	--	70	30	30
	長石 ^{#2} 粒径 1~10 μm (mass %)	--	30	--	--	--	--
	粘度 (cps)	5,000	5,000	5,000	5,000	5,000	5,000
	塗布量 (固形分) ^{#3} (g/m ²)	500 (5)	500 (5)	500 (5)	500 (5)	250 (2.5)	150 (1.5)
	巻回作業性	良好	良好	やや染み出しやすい	ややはがれやすい	良好	はがれやすい
	含有率 ^{#4} (mass %)	0 (1.9)	2.3 (4.2)	0 (1.9)	0 (1.9)	0 (1.7)	0 (1.4)
	耐熱性 ^{#5}	○	△	○	○	△	×

#1 ; MgO を 23 mass % 含有

#2 ; Na₂O, K₂O を 9 mass % 含有

#3 ; 括弧内は無機系不織布の質量に対する無機粉体と無機接着剤の合計質量の倍率 (倍)

#4 ; 無機材料全体におけるアルカリ金属酸化物の含有率、括弧内は無機材料全体におけるアルカリ金属酸化物及びアルカリ土類金属酸化物の合計含有率

#5 ; ○・・溶融金属保持パイプのふくれも割れもなし

△・・溶融金属保持パイプがややふくれるものの、割れはなし

×・・溶融金属保持パイプがふくれ、割れが発生

[0033] (Example 6) The molten-metal maintenance pipe with a die length [of 500mm] and an outer diameter of 66mm

was manufactured completely like the example 1 except having applied the water solution containing inorganic fine particles as shown in Table 2, and inorganic adhesive to the same inorganic system nonwoven fabric as an example 1 by the roll coater (500g/m²).

[0034]

[Table 2]

		実施例 6
無機遮蔽層構成成分	無機系不織布の面密度 (g/m ²)	100
	コロイダルシリカ 粒径 0.01~0.02 μm (mass %)	18
	蛙目粘土 粒径 0.02~10 μm (mass %)	18
	ムライト 粒径 1~10 μm (mass %)	36
	ムライト 粒径 10~100 μm (mass %)	28
	粘度 (cps)	5,000
	塗布量(固形分) ^{#1} (g/m ²)	500 (5)
	巻回作業性	良好
	含有率 ^{#2} (mass %)	0 (0)
	耐熱性 ^{#3}	○

#1: 括弧内は無機系不織布の質量に対する無機粉体と無機接着剤の合計質量の倍率(倍)

#2: 無機材料全体におけるアルカリ金属酸化物の含有率、括弧内は無機材料全体におけるアルカリ金属酸化物及びアルカリ土類金属酸化物の合計含有率

#3: ○・・・溶融金属保持パイプのふくれも割れもなし

△・・・溶融金属保持パイプがややふくれるものの、割れはなし

×・・・溶融金属保持パイプがふくれ、割れが発生

[0035] (Winding workability) The result of the winding workability at the time of manufacturing each molten-metal maintenance pipe of examples 1-6 and the example of a comparison is shown in Table 1 and 2. When the inorganic fine particles whose inorganic fine particles and mean particle diameter of less than 10 micrometers mean particle diameter 10-100 micrometers are intermingled from these results, it turns out that it excels in winding workability.

[0036] (Heat resistance test) The part from the lower limit of the molten-metal maintenance pipe of examples 1-6 and the example of a comparison to about 60mm was laid under the furan mold, respectively (it is a right angle to furan mold), and the lower limit of a molten-metal maintenance pipe was blocked. Subsequently, molten metal with a temperature of about 1,300 degrees C was poured in inside each molten-metal maintenance pipe from the lower limit of a molten-metal maintenance pipe to height of about 400mm. Subsequently, inside molten metal was heated with high-frequency-dielectric-heating equipment from the perimeter of a molten-metal maintenance pipe, and the temperature of molten metal was maintained for 30 minutes at about 1,300 degrees C. Then, the condition of each molten-metal maintenance pipe was observed. This result is also shown in Table 1 and 2.

[0037] From these results, if the content of the alkali-metal oxide in the whole (1) inorganic material is less than [2mass%] If the sum total mass of excelling with thermal resistance, (2) inorganic fine particles, and inorganic adhesive is twice [more than (especially 3 or more times)] the inorganic system nonwoven fabric Excelling in thermal resistance more, when excelling in thermal resistance more and the inorganic fine particles whose inorganic fine particles and mean particle diameter of less than 10 micrometers (3) mean particle diameter is 10-100 micrometers are intermingled, ****,

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(54) 【発明の名称】 溶融金属保持パイプ

(57) 【要約】

【課題】 溶融金属を長時間保持しても割れることなく保持でき、強度的及び溶融金属の遮蔽性に優れたパイプを提供すること。

【解決手段】 本発明の溶融金属保持パイプは、無機系繊維シートが無機粉体と無機接着剤とを含む無機遮蔽層を介して巻回積層されており、無機粉体と無機接着剤との合計質量が無機系繊維シートの質量の2倍以上のものである。

【特許請求の範囲】

【請求項1】 無機系繊維シートが無機粉体と無機接着剤とを含む無機遮蔽層を介して巻回積層されており、無機粉体と無機接着剤との合計質量が無機系繊維シートの質量の2倍以上であることを特徴とする溶融金属保持パイプ。

【請求項2】 無機粉体として、平均粒径が $10\mu\text{m}$ 未満のものと平均粒径が $10\sim 100\mu\text{m}$ のものとが混在していることを特徴とする、請求項1記載の溶融金属保持パイプ。

【請求項3】 無機材料全体におけるアルカリ金属酸化物の含有率が $2\text{mass}\%$ 以下であることを特徴とする、請求項1又は請求項2記載の溶融金属保持パイプ。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は溶融金属保持パイプに関する。より具体的には、鋳物製造時における押湯形成用のパイプや、溶融金属採取用容器の側面部分を構成するパイプなどとして使用できる溶融金属保持パイプに関する。

【0002】

【従来の技術】鋳物を製造する際には、鋳造欠陥を防ぐために従来から押湯が必要であった。しかしながら、この押湯は本来不必要なものであるため取り除く必要がある。そのため押湯によって、多くの金属を必要とする点、多くの金属を溶融させる必要がある点、押湯を取り除く必要がある点、など様々な無駄があった。

【0003】このような無駄をなくすために、鋳型キャピティーに連通するように鋳型に埋入、立設した耐火性パイプの外側に誘電コイルを遊嵌し、金属注湯時に誘導コイルで耐火性パイプ内の溶湯を誘導加熱して耐火性パイプ内の溶湯を凝固させる方法が知られている。この方法によれば押湯を小さくすることができ、少ない金属で済むため、溶融させる手間、押湯を取り除く手間などを軽減することができる。

【0004】ところで、この方法において重要な比重を占める耐火性パイプには、次のような耐熱性が必要である。つまり、 $1,200^{\circ}\text{C}\sim 1,500^{\circ}\text{C}$ の溶融金属を $20\sim 40$ 分間保持することによっても、また、誘電コイルによって溶融金属を加熱することによっても、耐火性パイプは割れることなく内側の溶融金属を保持できることが必要である。そのため、この耐火性パイプとして陶管や押出成形管を使用したか、これらの耐火性パイプは耐熱衝撃性が低く（脆い）、割れが発生しやすいため、使用するのが困難であった。他方、セラミック繊維を使用し、吸引成形した耐火性パイプは強度が低かったり、溶融金属を遮蔽できないため、使用するのが困難であった。

【0005】

【発明が解決しようとする課題】本発明は上記の問題点

を解決するためになされたものであり、溶融金属を長時間保持しても割れることなく保持でき、強度的及び溶融金属の遮蔽性に優れたパイプを提供することを目的とする。

【0006】

【課題を解決するための手段】本発明の溶融金属保持パイプは、無機系繊維シートが無機粉体と無機接着剤とを含む無機遮蔽層を介して巻回積層されており、無機粉体と無機接着剤との合計質量が無機系繊維シートの質量の2倍以上のものである。このように本発明の溶融金属保持パイプは無機系繊維シートを使用しているため、溶融金属を長時間保持しても割れることがなく、強度的にも優れている。また、無機粉体と無機接着剤とを大量に含む無機遮蔽層が形成されているため、溶融金属の遮蔽性にも優れている。

【0007】上記無機粉体として、平均粒径が $10\mu\text{m}$ 未満のものと平均粒径が $10\sim 100\mu\text{m}$ のものとが混在した溶融金属保持パイプは、これら無機粉体が緻密な状態で配置しやすいため、強度をより向上させることができ、又溶融金属の遮蔽性もより優れている。

【0008】また、無機材料全体におけるアルカリ金属酸化物の含有率が $2\text{mass}\%$ 以下の溶融金属保持パイプは、無機成分の融点降下を生じにくいため耐熱性に優れ、より割れを生じにくいものである。

【0009】

【発明の実施の形態】本発明の無機系繊維シートは耐熱性に優れるように無機繊維を主体としており、この無機系繊維シートが存在により溶融金属保持パイプに耐熱衝撃性が付与される。この繊維シートの態様としては、例えば、織物、編物、不織布であることができるが、無機粉体などの保持性に優れるように、不織布であるのが好ましい。この好適である不織布は、例えば、常法の湿式抄造法や乾式法により製造することができるが、均一性に優れた湿式抄造法により製造するのがより好ましい。

【0010】この無機系繊維シートを構成する無機繊維としては、例えば、シリカーアルミナ繊維、アルミナ繊維、シリカ繊維、ガラス繊維、炭素繊維、炭化ケイ素繊維、ロックウール、金属繊維などを1種類以上使用できる。これらの中でも高温における繊維強度の維持性に優れたシリカーアルミナ繊維、アルミナ繊維、シリカ繊維、或いは炭化ケイ素繊維を好適に使用できる。

【0011】なお、本発明における無機系繊維シートは $50\text{mass}\%$ 以上の無機繊維を含んでいれば良いが、好ましくは $70\text{mass}\%$ 以上の無機繊維を含んでおり、より好ましくは $90\text{mass}\%$ 以上の無機繊維を含んでいる。なお、無機系繊維シートを構成する無機繊維以外の繊維として、耐熱性に悪影響を及ぼさない範囲内で、メタ系又はパラ系の芳香族ポリアミド繊維、ポリアミドイミド繊維、ポリテトラフルオロエチレン繊維、芳香族ポリエーテルアミド繊維、ポリベンツイミダ

ゾール繊維などの耐熱性繊維、場合によっては、再生繊維、半合成繊維、合成繊維、植物繊維、動物繊維を含ませることもできる。

【0012】この無機系繊維シートを構成する繊維の繊維径は均一性に優れるように、 $0.5 \sim 20 \mu\text{m}$ であるのが好ましく、 $1 \sim 10 \mu\text{m}$ であるのがより好ましい。また、繊維長は耐熱衝撃性に優れるように、 1mm 以上であるのが好ましい。なお、好適である湿式抄造法により不織布を製造する場合には、製造上 20mm 長以下であるのが好ましい。

【0013】この無機系繊維シートの見掛け密度は耐熱衝撃性及び形態安定性に優れるように、 $0.05 \sim 0.5 \text{ g/cm}^3$ であるのが好ましく、 $0.1 \sim 0.3 \text{ g/cm}^3$ であるのがより好ましい。

【0014】本発明の熔融金属保持パイプは上記のような無機系繊維シートが無機粉体と無機接着剤とを含む無機遮蔽層を介して接着されている。この無機接着剤としては、例えば、シリカゾル、アルミナゾル、ジルコニアゾル、ケイ酸塩、リン酸塩、或いはアルミナセメント、マグネシアセメント、ジルコニアセメント等のセメント類等を1種類以上使用できる。

【0015】また、無機粉体としては、例えば、長石、マグネシア、ケイソウ土、シリカ、シリカアルミナ、ムライト、アルミナ、水酸化アルミニウム、ジルコン、ジルコニア、酸化チタン、酸化マグネシウム、酸化カルシウム、ケイ酸カルシウム、ケイ酸マグネシウム、シラス、シラスバルーン、バーライト、ガラス、ガラスバルーン、ドロマイト、シャモット、雲母、コーゼライト、窒化ケイ素、窒化ホウ素、炭化ケイ素、炭化ホウ素、金属系粉体、炭素系粉体、或いはカオリン、ベントナイト、ロウ石、滑石、バイヤライト、ダイアスポア、セピオライト、アタパルジャイト、モンモリロナイト、ヘクトライト、合成フッ素雲母、スメクタイトなどの粘土鉱物を使用することができる。

【0016】これら無機粉体の中でも粘土鉱物を含んでいると、耐熱性及び不燃性に優れ、しかも無機粉体と無機接着剤との混合液の粘度を調整でき、無機粉体を均一に分散させる効果があるため好適に使用できる。この粘土鉱物は無機粉体全体の $1 \sim 30 \text{ mass\%}$ を占めるのが好ましい。 1 mass\% 未満では粘度の調整が困難となり、無機粉体を均一に分散させるのが困難になる傾向があり、 30 mass\% を越えると、混合液の保液性が高くなり、多量の無機粉体及び無機接着剤からなる無機遮蔽層を形成できなかったり、無機系繊維シート中に粉体が侵入できないことにより強度が低下する傾向があるため、より好ましくは $3 \sim 20 \text{ mass\%}$ である。なお、上記粘土鉱物の一部として、或いは代りに、ケイ酸ソーダ、粒径 $1 \mu\text{m}$ 以下の超微粒子、或いは有機高分子を用いて粘度を調整しても良い。

【0017】この無機粉体としては、平均粒径が 0.1

$\sim 100 \mu\text{m}$ のものを使用できるが、平均粒径 $10 \mu\text{m}$ 未満のものと平均粒径 $10 \mu\text{m} \sim 100 \mu\text{m}$ のものとを併用すると、無機粉体が緻密な状態で配置しやすく、熔融金属保持パイプの強度をより向上させることができたり、熔融金属の遮蔽性にも優れているため好適である。また、併用することにより、多量の無機粉体と無機接着剤とを含む均一な無機遮蔽層を形成できるため、熔融金属の遮蔽性により優れるという効果も奏する。更には、無機系繊維シートの厚さ方向において、無機粉体と無機接着剤との分布状態に差を設けることができるため、割れをより生じにくくなる、という効果も奏する。

【0018】この無機粉体を併用する場合、平均粒径 $10 \mu\text{m}$ 未満の無機粉体と平均粒径 $10 \mu\text{m} \sim 100 \mu\text{m}$ の無機粉体との質量比率は、大量の無機粉体を含む無機遮蔽層を形成できるように、また、加工性に優れ、均一な無機遮蔽層を形成できるように、 $1:9 \sim 9:1$ であるのが好ましく、 $3:7 \sim 7:3$ であるのがより好ましい。なお、平均粒径 $10 \mu\text{m}$ 未満の無機粉体と平均粒径 $10 \mu\text{m} \sim 100 \mu\text{m}$ の無機粉体とは同じ種類であっても違う種類であっても良い。また、平均粒径 $10 \mu\text{m}$ 未満の無機粉体及び/又は平均粒径 $10 \mu\text{m} \sim 100 \mu\text{m}$ の無機粉体は1種類以上から構成されていれば良い。

【0019】また、無機粉体と無機接着剤との比率(固形分)は、接着性に優れるように、また大量の無機粉体と無機接着剤とを含む無機遮蔽層を形成できるように、 $99:1 \sim 50:50$ であるのが好ましく、 $95:5 \sim 70:30$ であるのがより好ましい。

【0020】本発明の熔融金属保持パイプは無機系繊維シートが、上述のような無機遮蔽層を介して巻回積層されたものであり、この無機粉体と無機接着剤の合計質量が無機系繊維シートの質量の2倍以上(好ましくは2.5倍以上、より好ましくは3倍以上)と大量に存在しているため、熔融金属の遮蔽性に優れている。

【0021】また、無機材料全体におけるアルカリ金属酸化物の含有率が 2 mass\% 以下(好ましくは 1.5 mass\% 以下、より好ましくは 1 mass\% 以下、最も好ましくは 0.5 mass\% 以下)であると、無機成分の融点降下を生じにくく、熔融金属を保持した際に割れをより生じにくいため好適である。なお、アルカリ土類金属酸化物はアルカリ金属酸化物よりも無機成分の融点降下を引き起こす作用が小さいものの、融点降下を引き起こす作用を有するため、アルカリ金属酸化物とアルカリ土類金属酸化物の無機材料全体における合計含有率が 3 mass\% 以下であるのが好ましく、 2.5 mass\% 以下であるのがより好ましく、 2 mass\% 以下であるのが最も好ましい。この無機材料とは無機繊維、無機粉体、無機接着剤など、熔融金属保持パイプを構成する無機成分からなる材料を意味する。したがって、無機繊維としては、シリカ繊維、炭化ケイ素繊維などを好適に使用できる。

また、無機粉体としては、ケイソウ土、シリカ、シリカアルミナ、ムライト、アルミナ、水酸化アルミニウム、ジルコン、シャモット、バーライト、ジルコニア、酸化チタン、窒化ケイ素、窒化ホウ素、炭化ケイ素、炭化ホウ素、金属系粉体、炭素系粉体などを好適に使用できる。更に、無機接着剤としては、シリカゾル、アルミナゾル、ジルコニアゾルなどを好適に使用できる。

【0022】このような本発明の熔融金属保持パイプは、例えば次のようにして製造することができる。まず、無機系繊維シート、無機粉体と無機接着剤との混合溶液、及び乾燥により収縮する芯材（以下、「収縮性芯材」という）を用意する。

【0023】次いで、無機系繊維シートに無機粉体と無機接着剤との混合溶液を付与した後に収縮性芯材に巻回する。この無機系繊維シートに無機粉体と無機接着剤との混合溶液を付与する方法としては、例えば、ロールコーター、ナイフコーター、カーテンコーターなどの塗布機を用いて、無機系繊維シートの片面に塗布する方法や、含浸コーターなどにより無機系繊維シート全体に含浸する方法などがある。これらの中でも、塗布機により片面のみに塗布すると、付与量を一定に制御しやすく、しかも作業環境的にも優れているため好適である。

【0024】また、無機粉体と無機接着剤との混合溶液は無機遮蔽層を形成することになるため、より多量の混合溶液を付与できるのが好ましい。そのため、混合溶液の粘度は100~10,000cps程度であるのが好ましい。

【0025】この無機粉体と無機接着剤との混合溶液を付与した無機系繊維シートの収縮性芯材への巻回方法としては、例えば、平巻きや螺旋状に巻回する方法がある。また、この無機系繊維シートは収縮性芯材上に何層となるように巻回しても良いが、均一で強度的かつ熔融金属遮蔽性に優れるように、3層以上となるように巻回するのが好ましい。

【0026】次いで、収縮性芯材に上記混合溶液を付与した無機系繊維シートを巻回した状態で乾燥した後、収

縮性芯材を引き抜くことにより、本発明の熔融金属保持パイプを製造することができる。つまり、混合溶液を付与した無機系繊維シートを収縮性芯材に巻回した際に膨潤した収縮性芯材が、乾燥した際に収縮するため、熔融金属保持パイプを破損することなく容易に抜き取ることができるのである。

【0027】この収縮性芯材としては、混合溶液を構成する溶媒によって異なるが、例えば、溶媒が水系の場合には、紙や木材のようなセルロース系の材料からなる収縮性芯材を使用するのが好ましい。より具体的には、この溶媒が水系の場合、紙管、丸太材、角材、或いは水溶性高分子を成型したものを使用することができる。

【0028】また、乾燥方法としては、加熱しても風乾であっても良い。なお、風乾する場合には、収縮性芯材を抜き取りやすいように、除湿するのがより好ましい。

【0029】以下に本発明の実施例を記載するが、本発明は以下の実施例に限定されるものではない。

【0030】

【実施例】（実施例1~5、比較例）湿式抄造法により、シリカーアルミナ繊維（繊維径2~3 μ m、繊維長1~10mm）を3mass%のポリビニルアルコール繊維で結合した、面密度100g/m²、厚さ0.5mm、見掛け密度0.2g/cm³の無機系不織布を製造した。

【0031】次いで、表1に示すような無機粉体と無機接着剤を含む水溶液を、ロールコーターにより上記無機系不織布の片面に表1に示す量だけ塗布した。次いで、表面を耐水化処理した紙管（内径50mm、外径60mm）上に、無機粉体と無機接着剤を含む水溶液を塗布した無機系不織布を5回平巻きした。その後、40℃で通風しながら10時間乾燥した後、前記紙管を抜き取り、裁断して、長さ500mm、外径66mmの熔融金属保持パイプを製造した。

【0032】

【表1】

	実施例1	実施例2	実施例3	実施例4	実施例5	比較例
無機系不織布の面密度 (g/m^2)	100	100	100	100	100	100
無機系不織布の成分						
コロイダルシリカ 粒径 $0.01 \sim 0.02 \mu m$ (mass%)	20	20	20	20	20	20
セピオライト ^{#1} 粒径 $0.02 \sim 10 \mu m$ (mass%)	10	10	10	10	10	10
ムライト 粒径 $1 \sim 10 \mu m$ (mass%)	40	20	70	---	40	40
ムライト 粒径 $10 \sim 100 \mu m$ (mass%)	30	20	---	70	30	30
長石 ^{#2} 粒径 $1 \sim 10 \mu m$ (mass%)	---	30	---	---	---	---
粘度 (cps)	5,000	5,000	5,000	5,000	5,000	5,000
塗布量(固形分) ^{#3} (g/m^2)	500 (5)	500 (5)	500 (5)	500 (5)	250 (2.5)	150 (1.5)
塗回作業性	良好	良好	やや染み 出しやすい	やや染み れやすい	良好	はがれ やすい
含有率 ^{#4} (mass%)	0 (1.9)	2.3 (4.2)	0 (1.9)	0 (1.9)	0 (1.7)	0 (1.4)
耐熱性 ^{#5}	○	△	○	○	△	×

#1: MgOを23mass%含有

#2: Na₂O, K₂Oを9mass%含有

#3: 括弧内は無機系不織布の質量に対する無機粉体と無機接着剤の合計質量の倍率(倍)

#4: 無機材料全体におけるアルカリ金属酸化物の含有率、括弧内は無機材料全体におけるアルカリ金属酸化物及びアルカリ土類金属酸化物の合計含有率

#5: ○・・・溶融金属保持パイプのふくれも割れもなし

△・・・溶融金属保持パイプがややふくれるものの、割れはなし

×・・・溶融金属保持パイプがふくれ、割れが発生

【0033】(実施例6)表2に示すような無機粉体と 0mm、外径66mmの溶融金属保持パイプを製造し
 無機接着剤とを含む水溶液を、ロールコーターにより、 30 た。
 実施例1と同じ無機系不織布に塗布(500g/m²) 【0034】
 したこと以外は、実施例1と全く同様にして、長さ50 【表2】

		実施例6
	無機系不織布の面密度 (g/m^2)	100
無機 遮 蔽 層 構 成 分	コロイダルシリカ 粒径 $0.01 \sim 0.02 \mu m$ (mass%)	18
	珪目粘土 粒径 $0.02 \sim 10 \mu m$ (mass%)	18
	ムライト 粒径 $1 \sim 10 \mu m$ (mass%)	36
	ムライト 粒径 $10 \sim 100 \mu m$ (mass%)	28
	粘度 (cps)	5,000
	塗布量(固形分) ^{#1} (g/m^2)	500 (5)
	巻回作業性	良好
	含有率 ^{#2} (mass%)	0 (0)
	耐熱性 ^{#3}	○

#1; 括弧内は無機系不織布の質量に対する無機粉体と無機接着剤の合計質量の倍率(倍)

#2; 無機材料全体におけるアルカリ金属酸化物の含有率、括弧内は無機材料全体におけるアルカリ金属酸化物及びアルカリ土類金属酸化物の合計含有率

#3; ○・・・ 熔融金属保持パイプのふくれも割れもなし

△・・・ 熔融金属保持パイプがややふくれるものの、割れはなし

×・・・ 熔融金属保持パイプがふくれ、割れが発生

【0035】(巻回作業性) 実施例1～6及び比較例のそれぞれの熔融金属保持パイプを製造する際における、巻回作業性の結果を表1及び表2に示す。これらの結果から、平均粒径が $10 \mu m$ 未満の無機粉体と平均粒径が $10 \sim 100 \mu m$ の無機粉体とが混在していると、巻回作業性に優れていることがわかる。

【0036】(耐熱性試験) 実施例1～6及び比較例の30 熔融金属保持パイプの下端から約60mmまでの部分を、フランジ型にそれぞれ埋設(フランジ型に対して直角)して、熔融金属保持パイプの下端を封鎖した。次いで、それぞれの熔融金属保持パイプの内側に温度約 $1,300^\circ C$ の熔融金属を、熔融金属保持パイプの下端から約400mmの高さまで注入した。次いで、熔融金属保持パイプの周囲から内側の熔融金属を高周波誘電加熱装置により加熱して、熔融金属の温度を約 $1,300^\circ C$ に40 30分間維持した。その後、それぞれの熔融金属保持パイプの状態を観察した。この結果も表1及び表2に示す。

【0037】これらの結果から、(1)無機材料全体におけるアルカリ金属酸化物の含有率が2mass%以下であると、耐熱性により優れていること、(2)無機粉体と無機接着剤の合計質量が無機系不織布の2倍以上(特に3倍以上)であると、より耐熱性に優れているこ

と、及び(3)平均粒径が $10 \mu m$ 未満の無機粉体と平均粒径が $10 \sim 100 \mu m$ の無機粉体とが混在していると、より耐熱性に優れていること、がわかる。

【0038】

【発明の効果】本発明の熔融金属保持パイプは、無機系繊維シートが無機粉体と無機接着剤とを含む無機遮蔽層を介して巻回積層されており、無機粉体と無機接着剤との合計質量が無機系繊維シートの質量の2倍以上のものである。このように本発明の熔融金属保持パイプは無機系繊維シートを使用しているため、熔融金属を長時間保持しても割れることがなく、強度的にも優れている。また、無機粉体と無機接着剤とを大量に含む無機遮蔽層が形成されているため、熔融金属の遮蔽性にも優れている。

【0039】上記無機粉体として、平均粒径が $10 \mu m$ 未満のものと平均粒径が $10 \sim 100 \mu m$ のものとが混在した熔融金属保持パイプは、これら無機粉体が緻密な状態で配置しやすいため、強度をより向上させることができ、又熔融金属の遮蔽性もより優れている。

【0040】また、無機材料全体におけるアルカリ金属酸化物の含有率が2mass%以下の熔融金属保持パイプは、無機成分の融点降下を生じにくいため耐熱性に優れ、より割れを生じにくいものである。